

# Musselshell Watershed Project, Phase II



(Kestral Aerial Services, 2011)

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# Objectives

- Provide information regarding a major flood study / update
- Introduce and describe an approach to mapping large-scale river reaches
- Share preliminary results of the study

# Introduction

- Project Overview
  - Updates and new mapping to ~225 miles
  - Detailed and Limited Detailed methods

# Background

- 2011 flooding
  - Most severe mid- to lower Musselshell
- 2014 flood
  - Second large event
- Previous floods



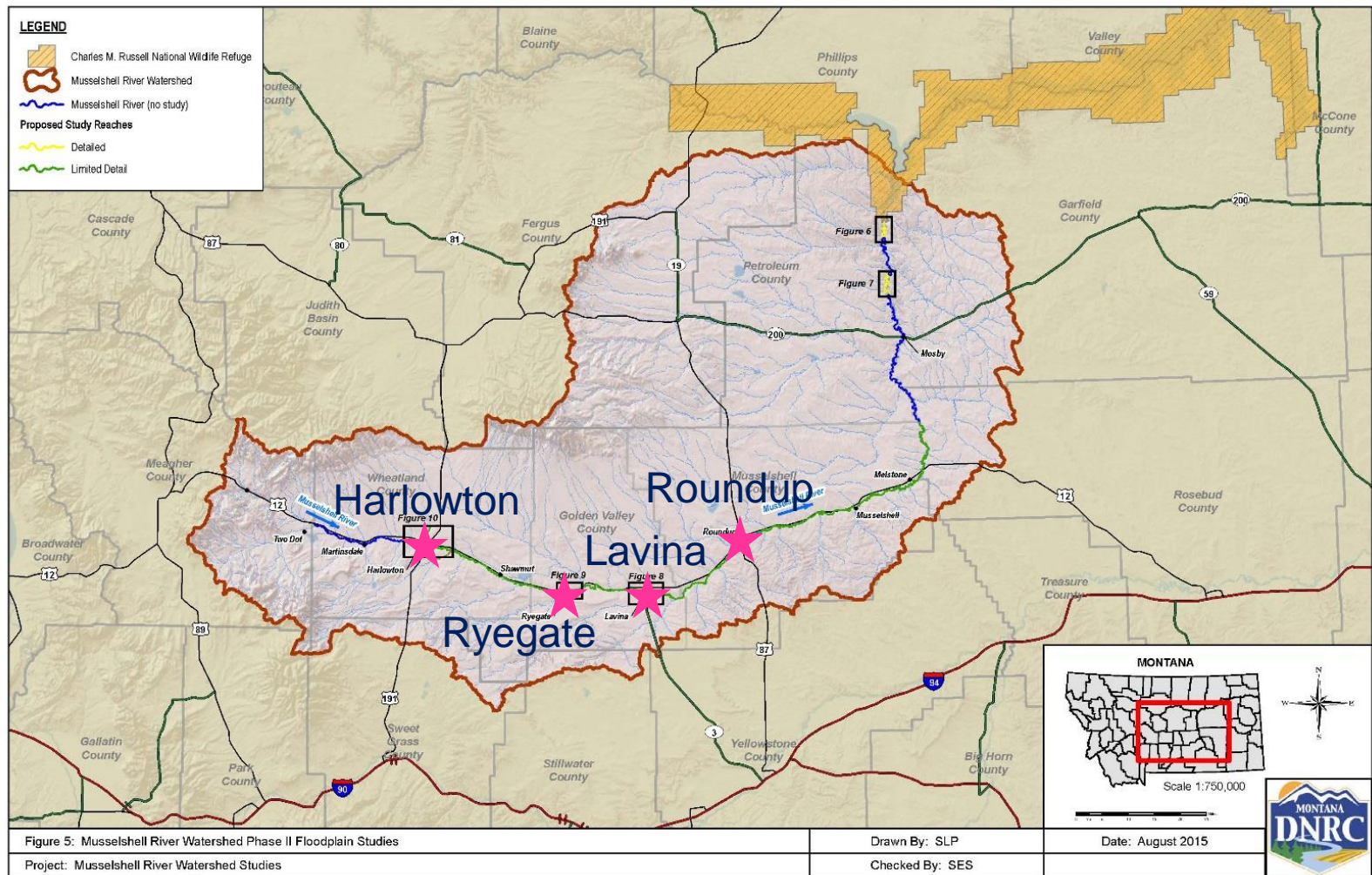
# Background

- River Assessment Triage Team (RATT)
  - Initiated by Musselshell Watershed Coalition and stakeholders
  - Characterized impacts and developed response strategies
  - DNRC funded effort – report issued 2012
- 2012 LiDAR
  - NRCS
  - Nearly 300 mile river corridor

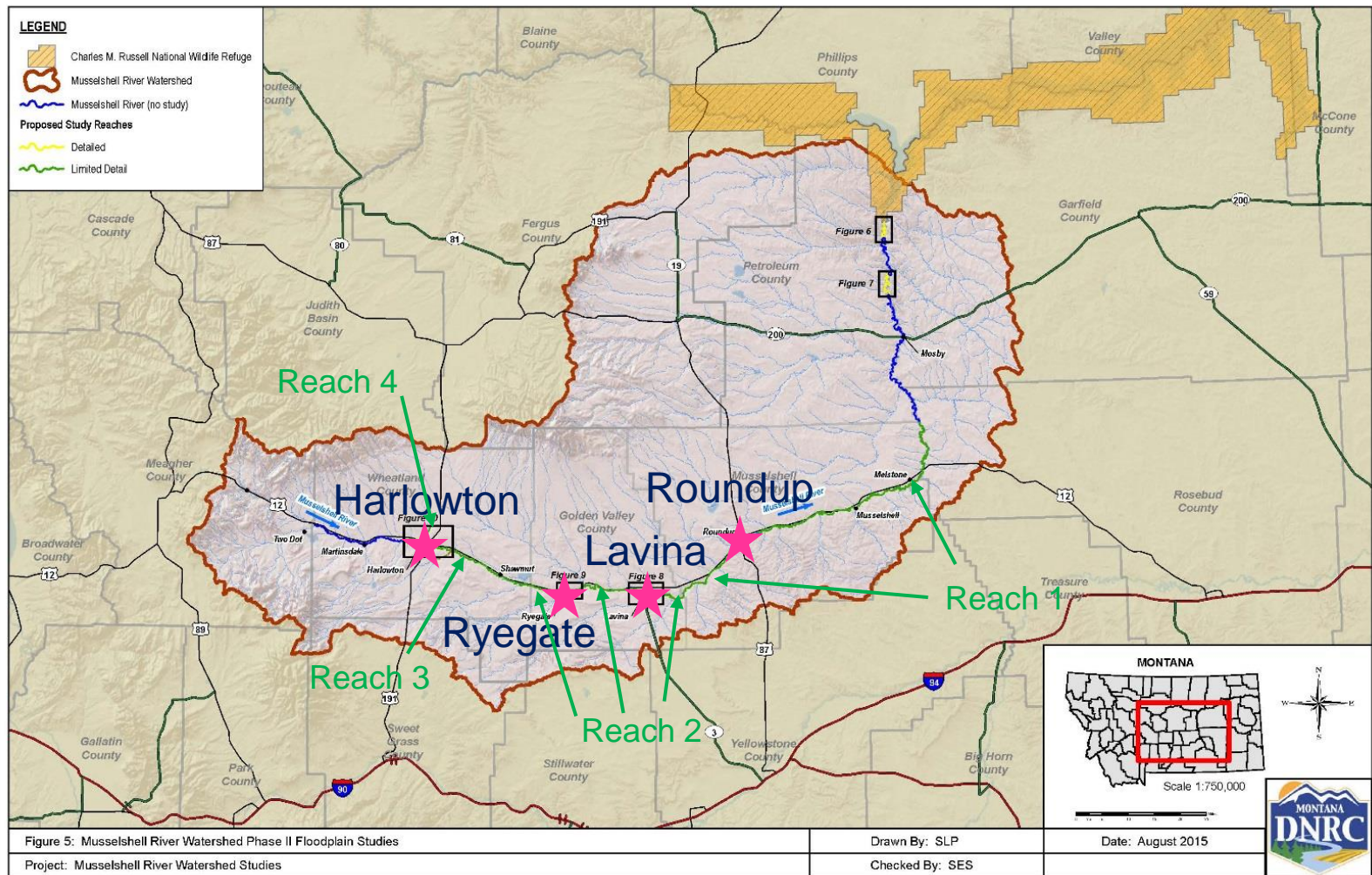
# Phase 1 Activities

- Hydraulic Structure Inventory and Assessment
- Hydrologic Analysis
  - Musselshell River
- Field Survey Structures at Roundup
  - Support map update at Roundup

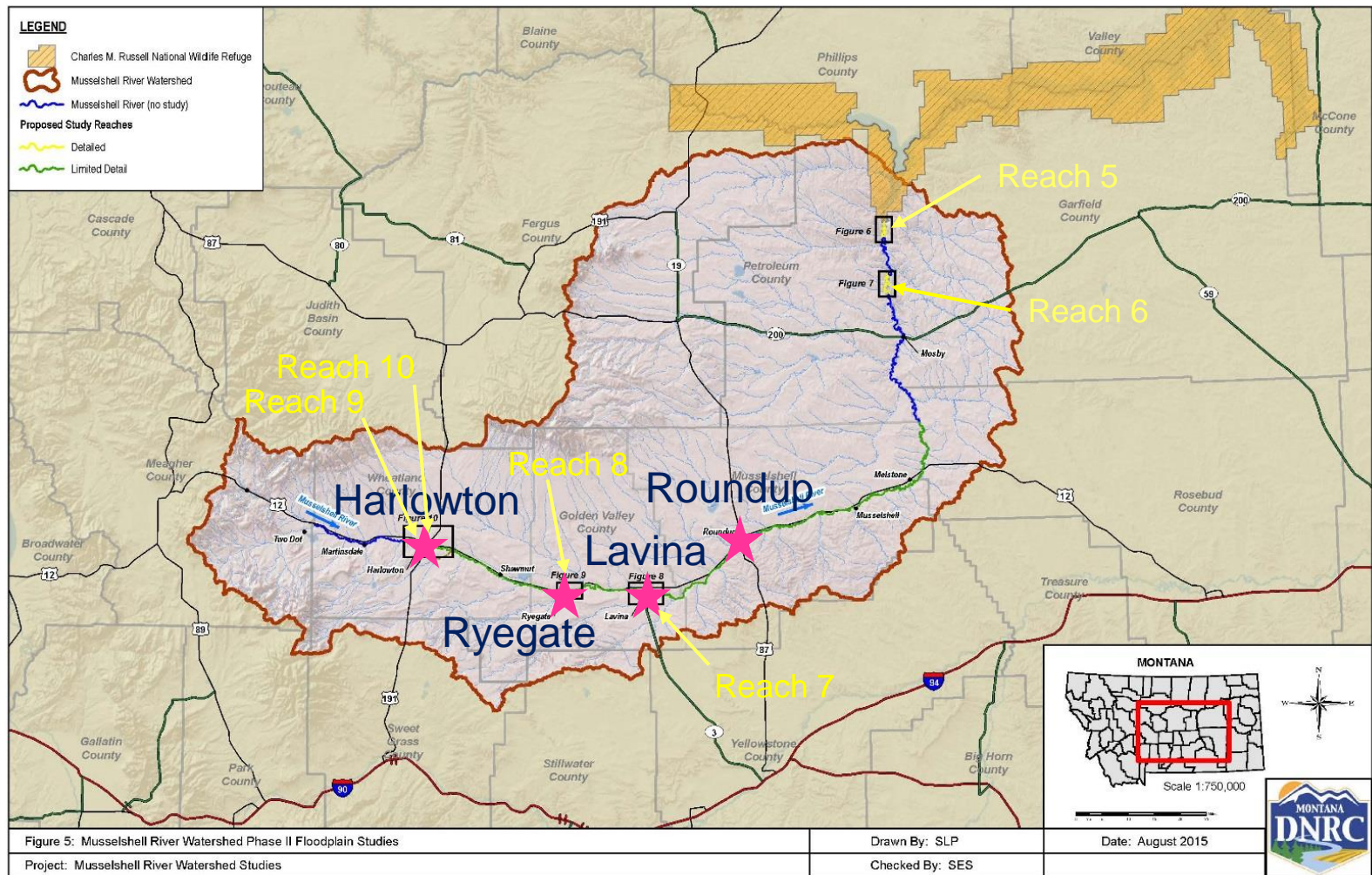
# Musselshell Watershed



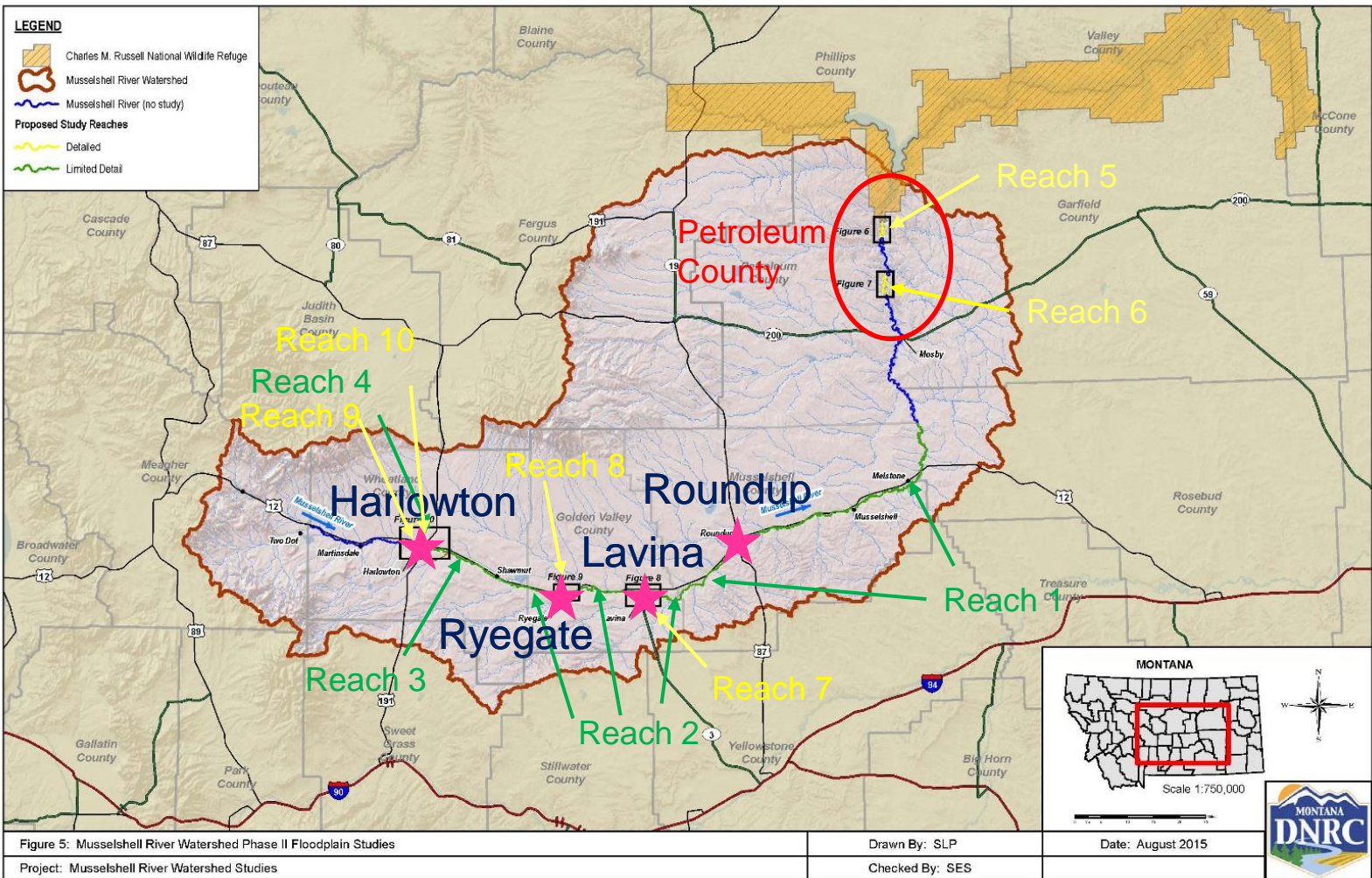
# Musselshell Watershed



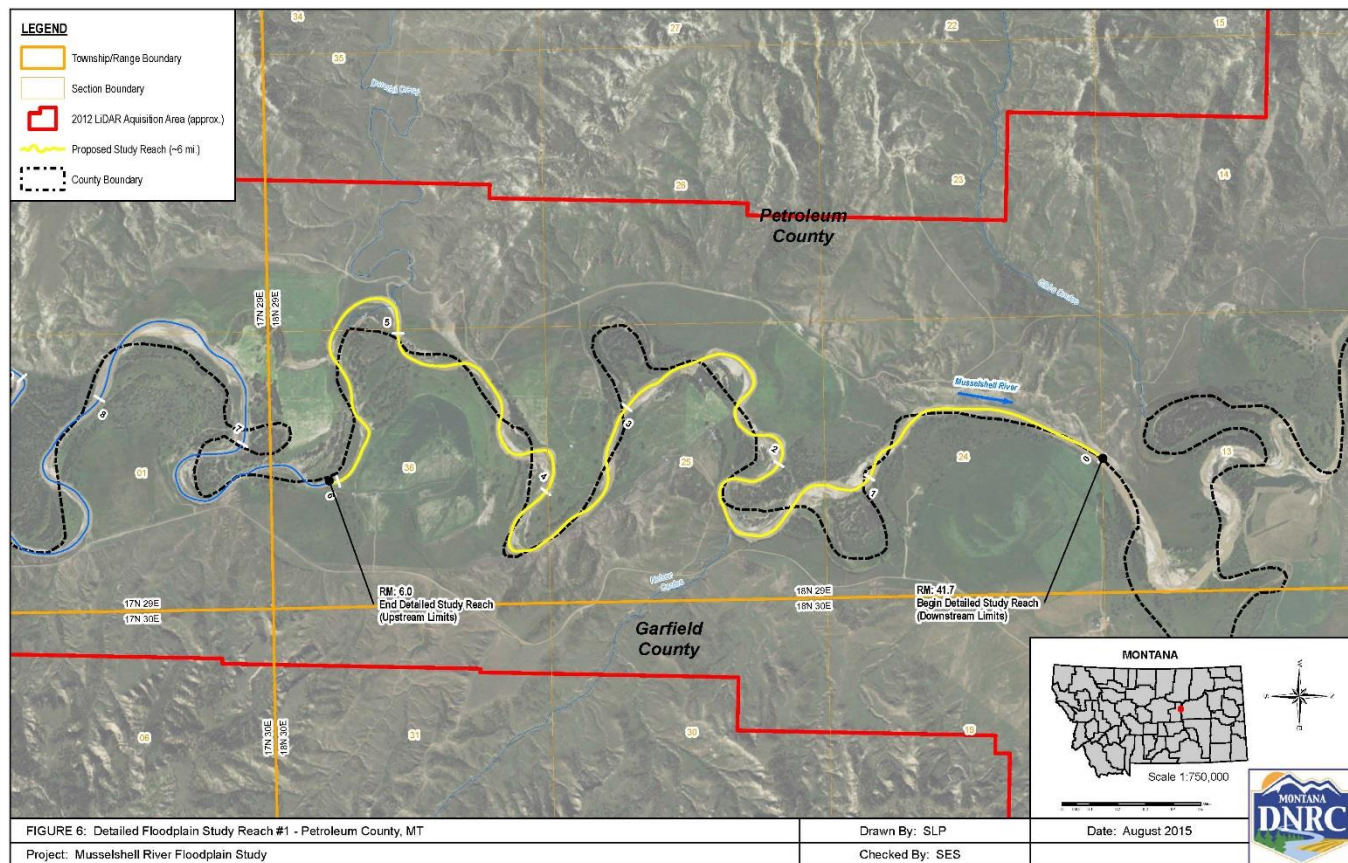
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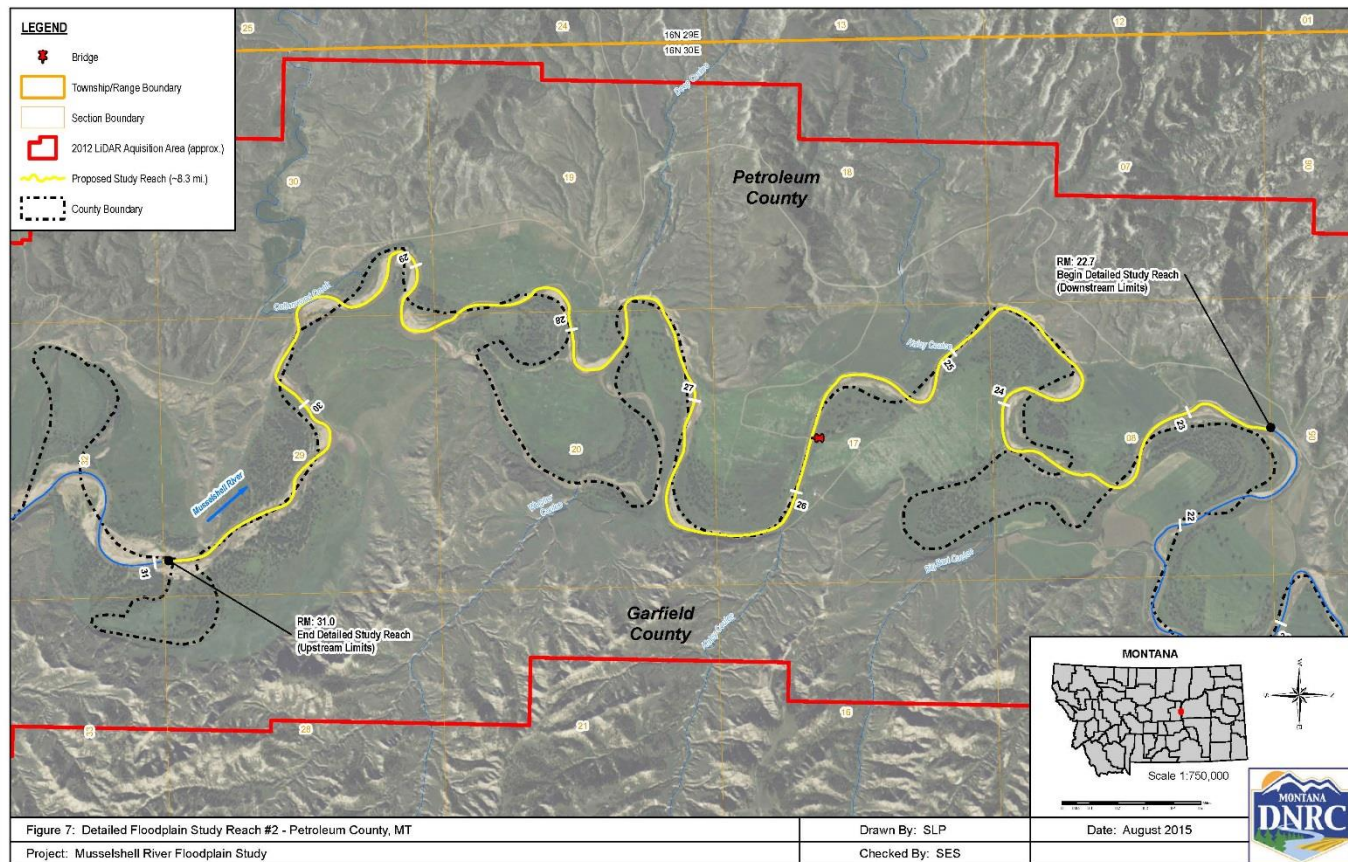
# Musselshell Watershed



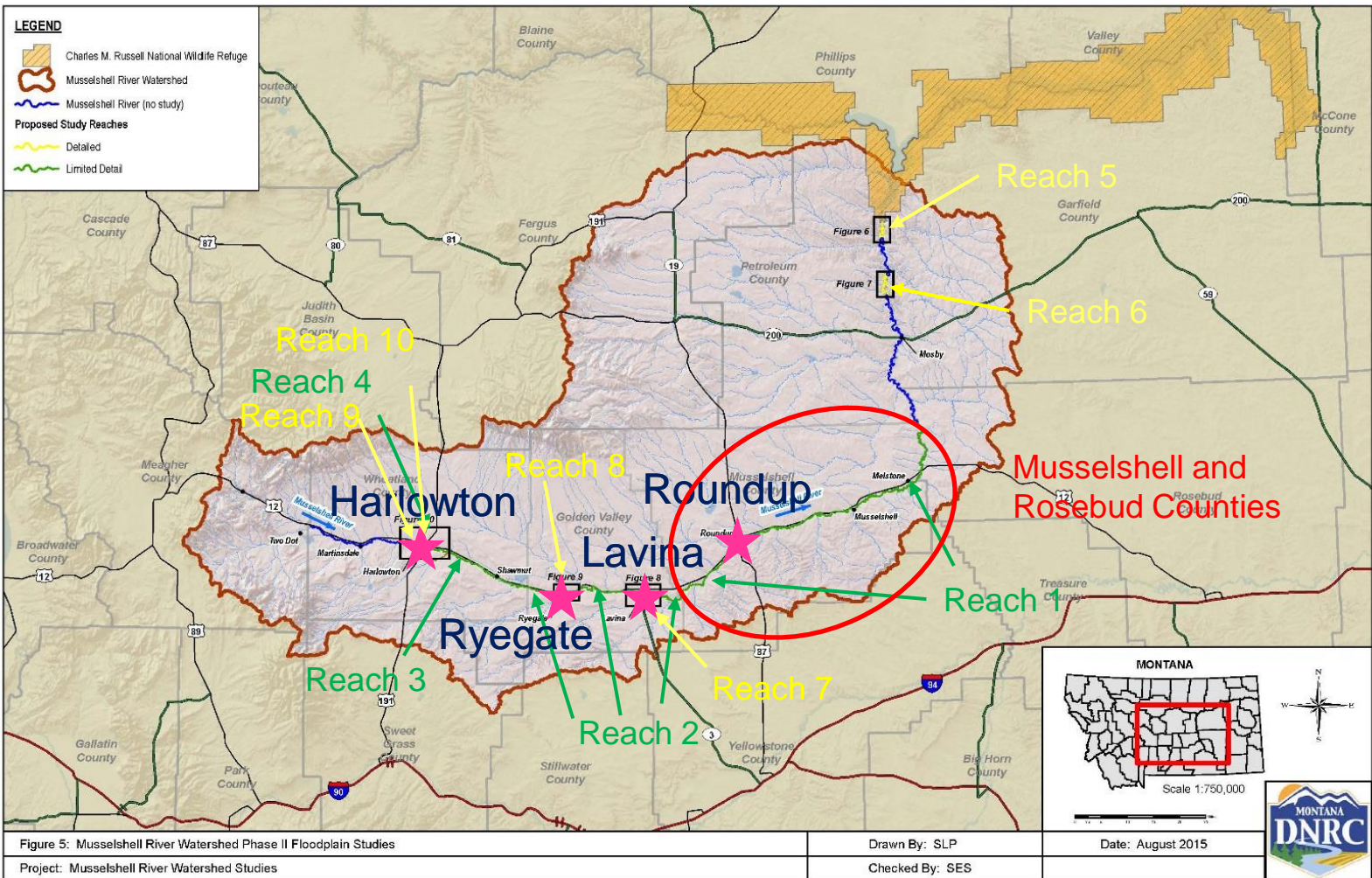
# Petroleum County (Reach 5 Detailed – 6 miles)



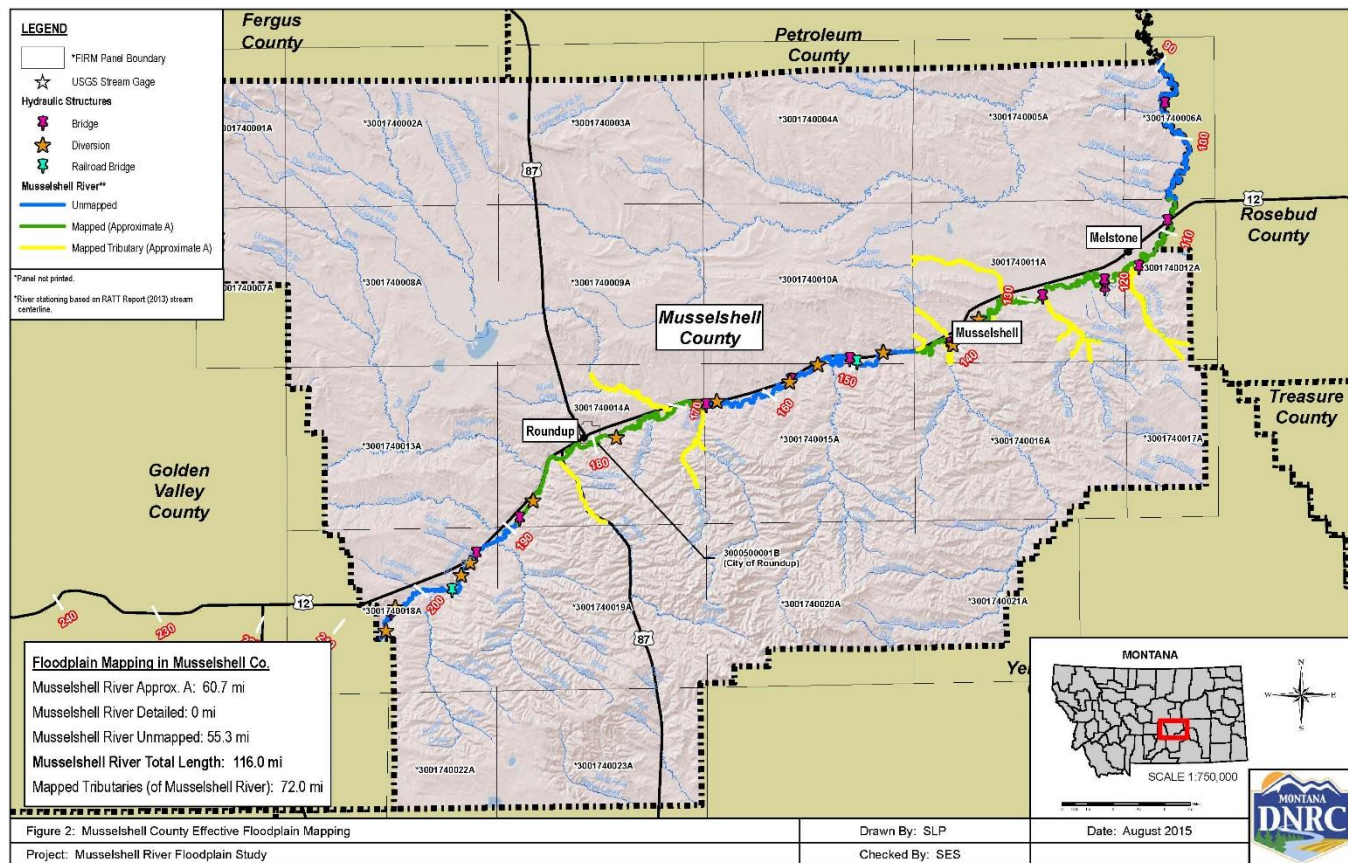
# Petroleum County (Reach 6 – 8.3 miles)



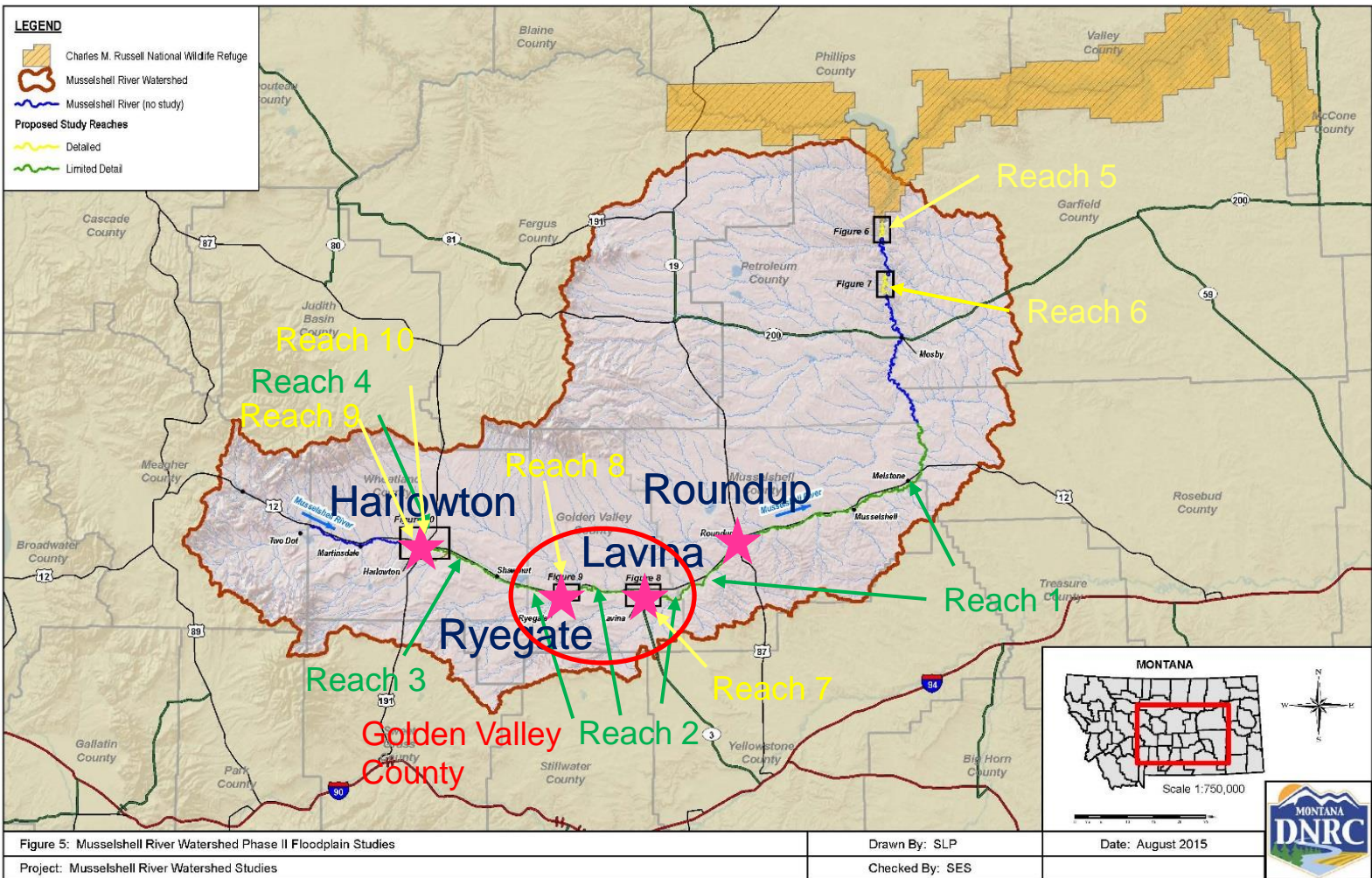
# Musselshell Watershed



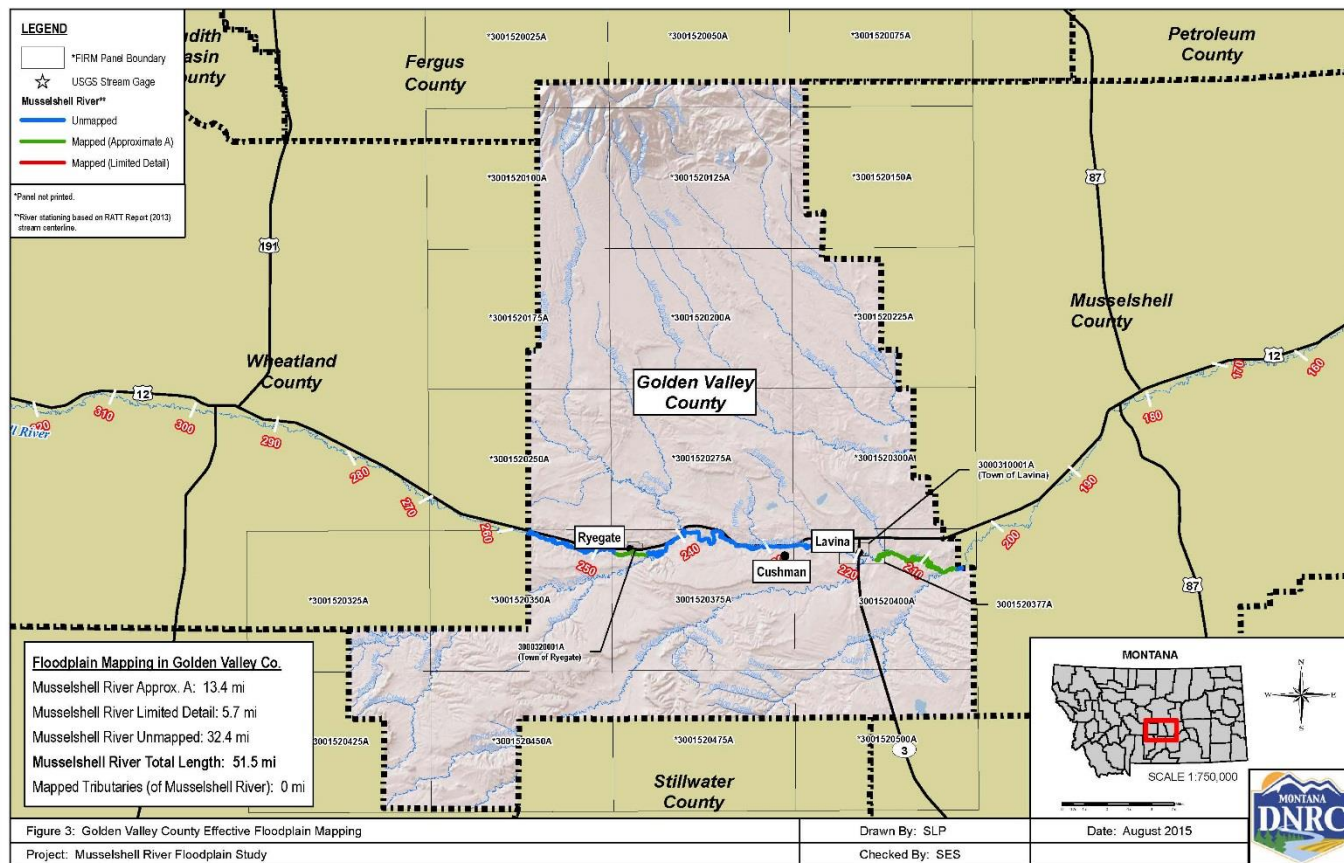
# Musselshell and Rosebud Counties



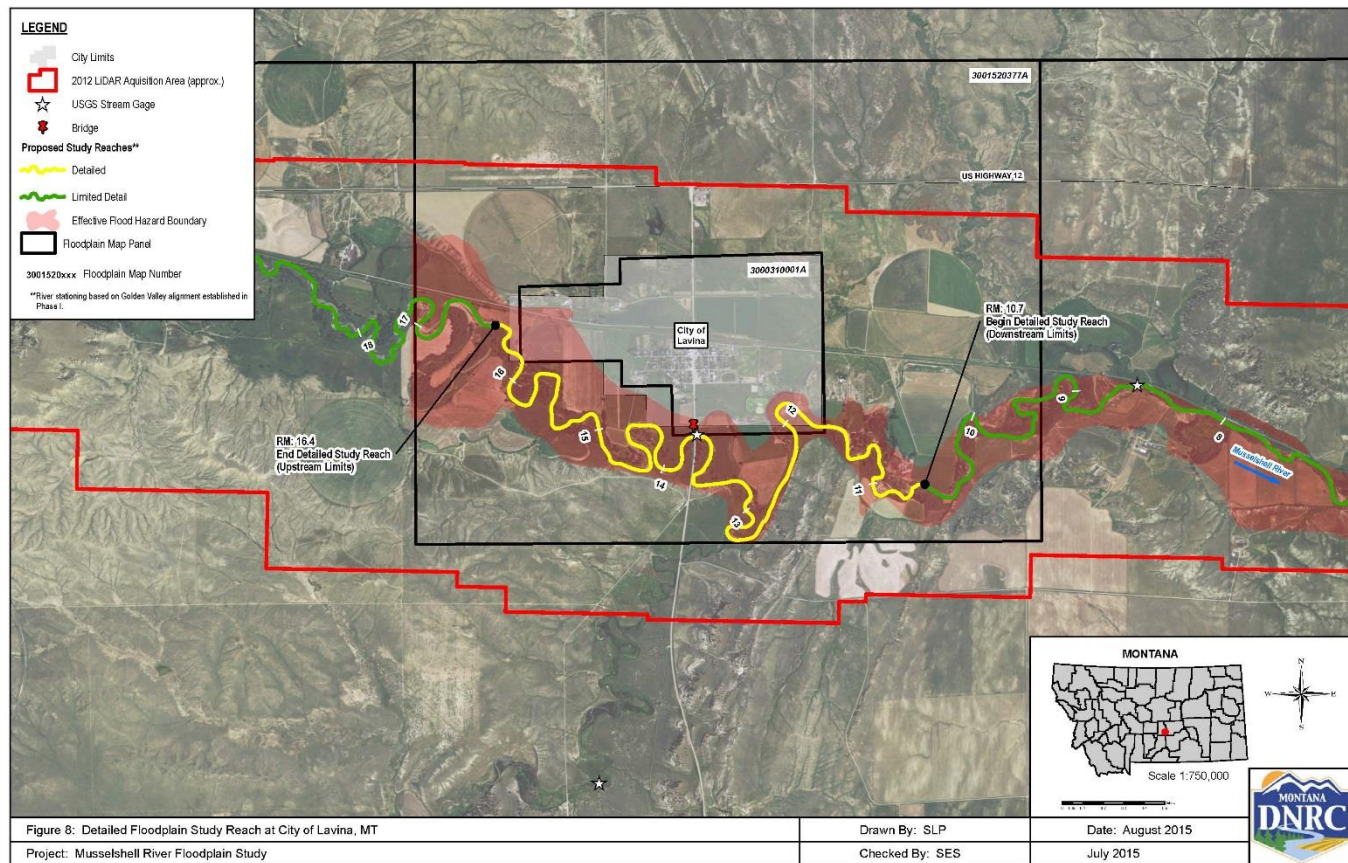
# Musselshell Watershed



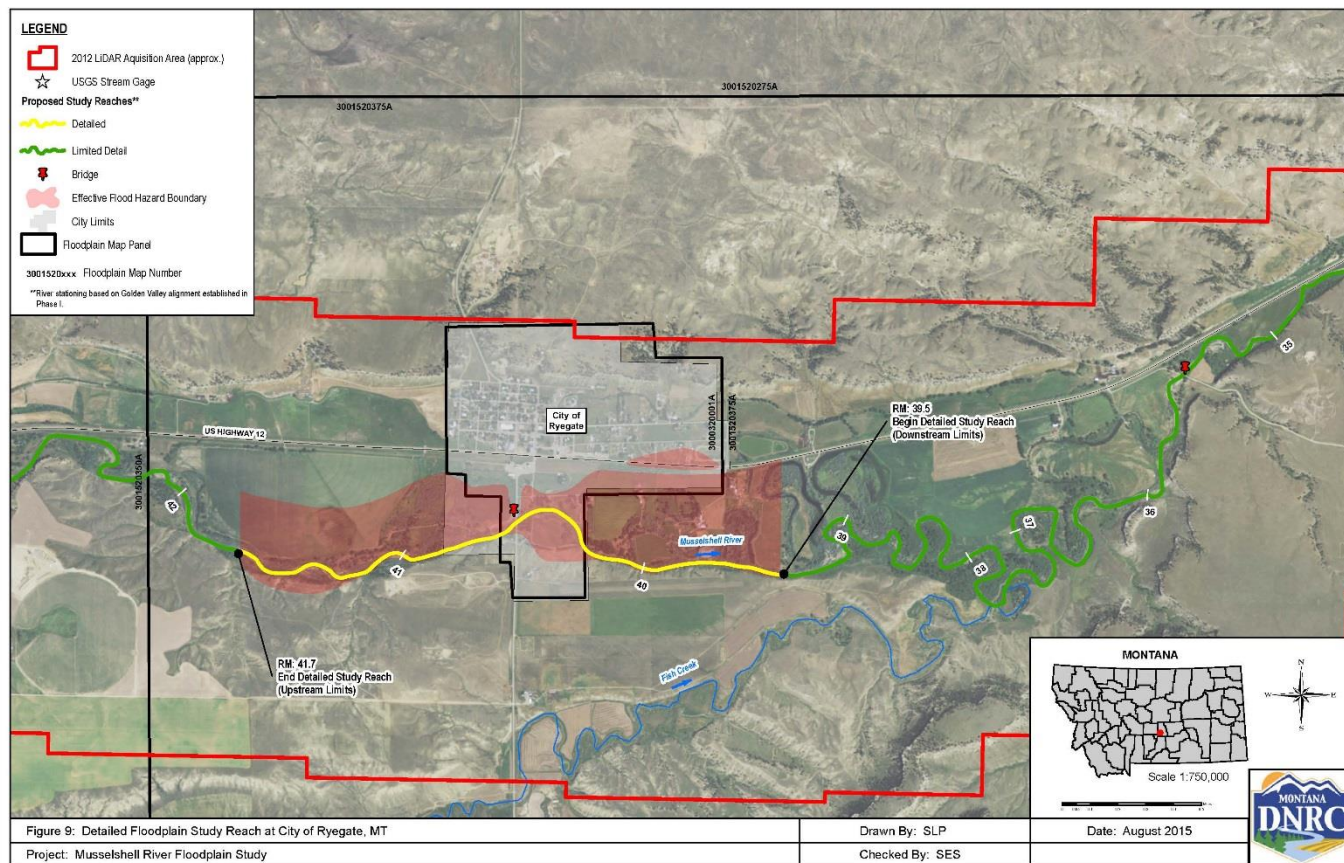
# Golden Valley County Lavina and Ryegate



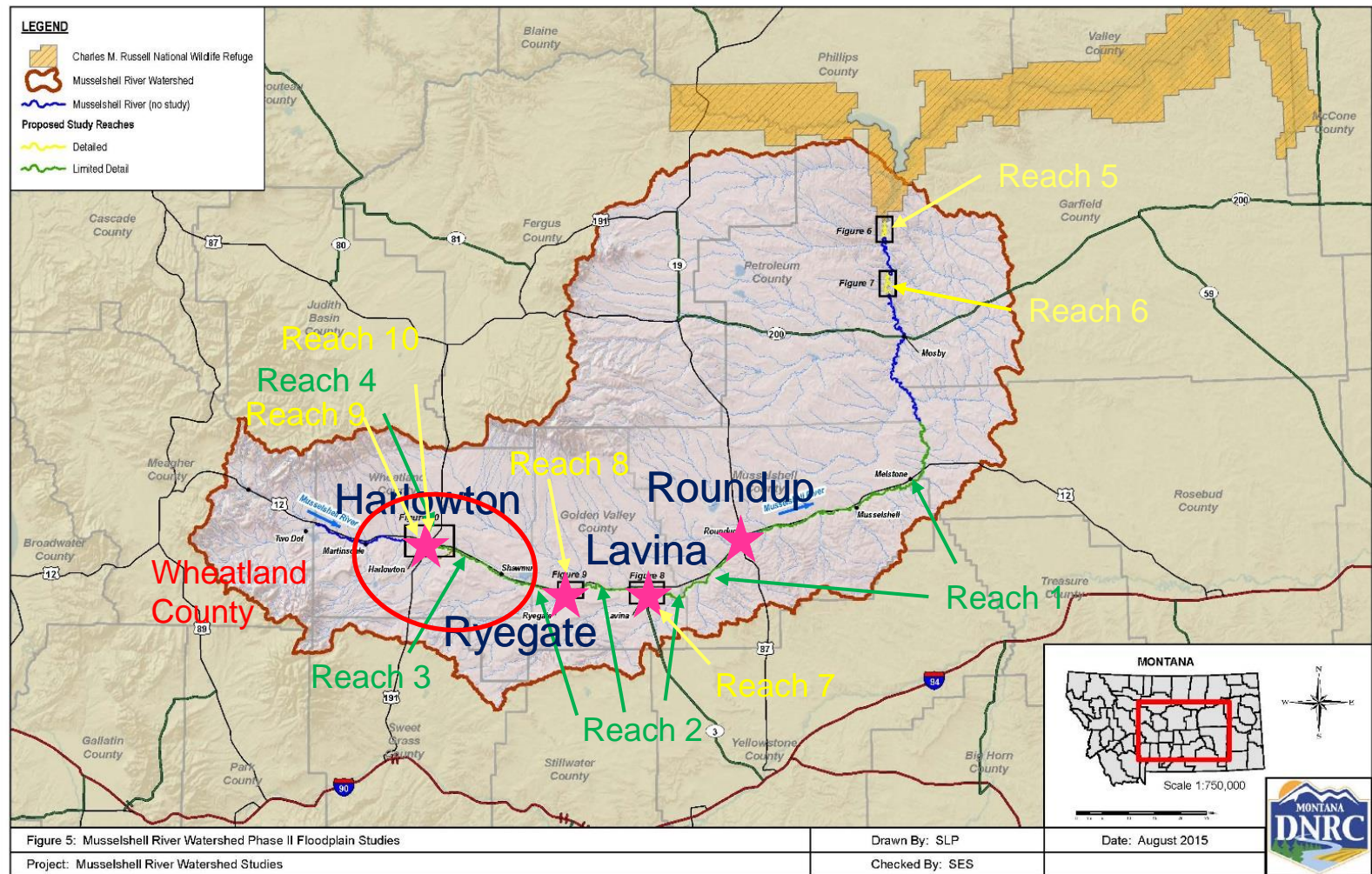
# Lavina



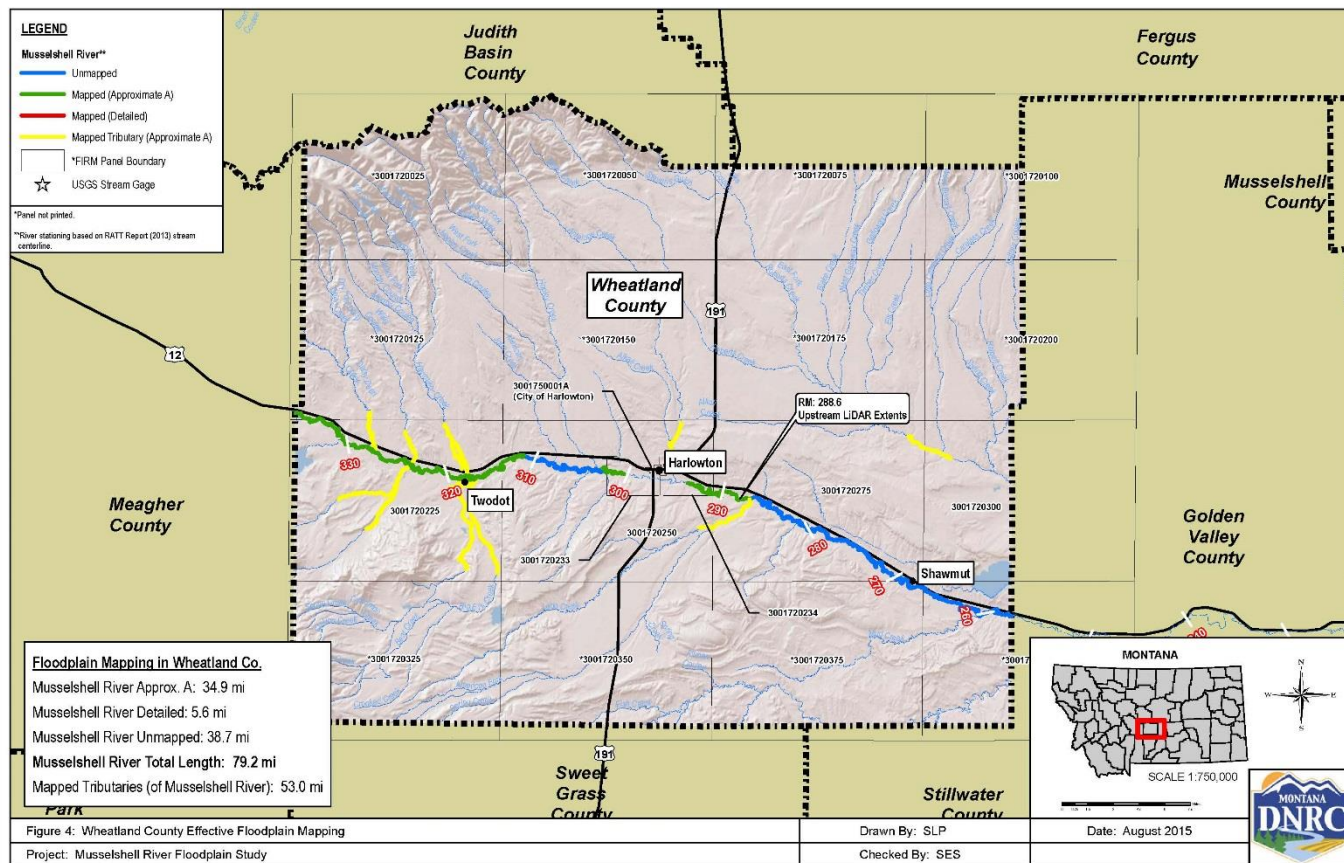
# Ryegate



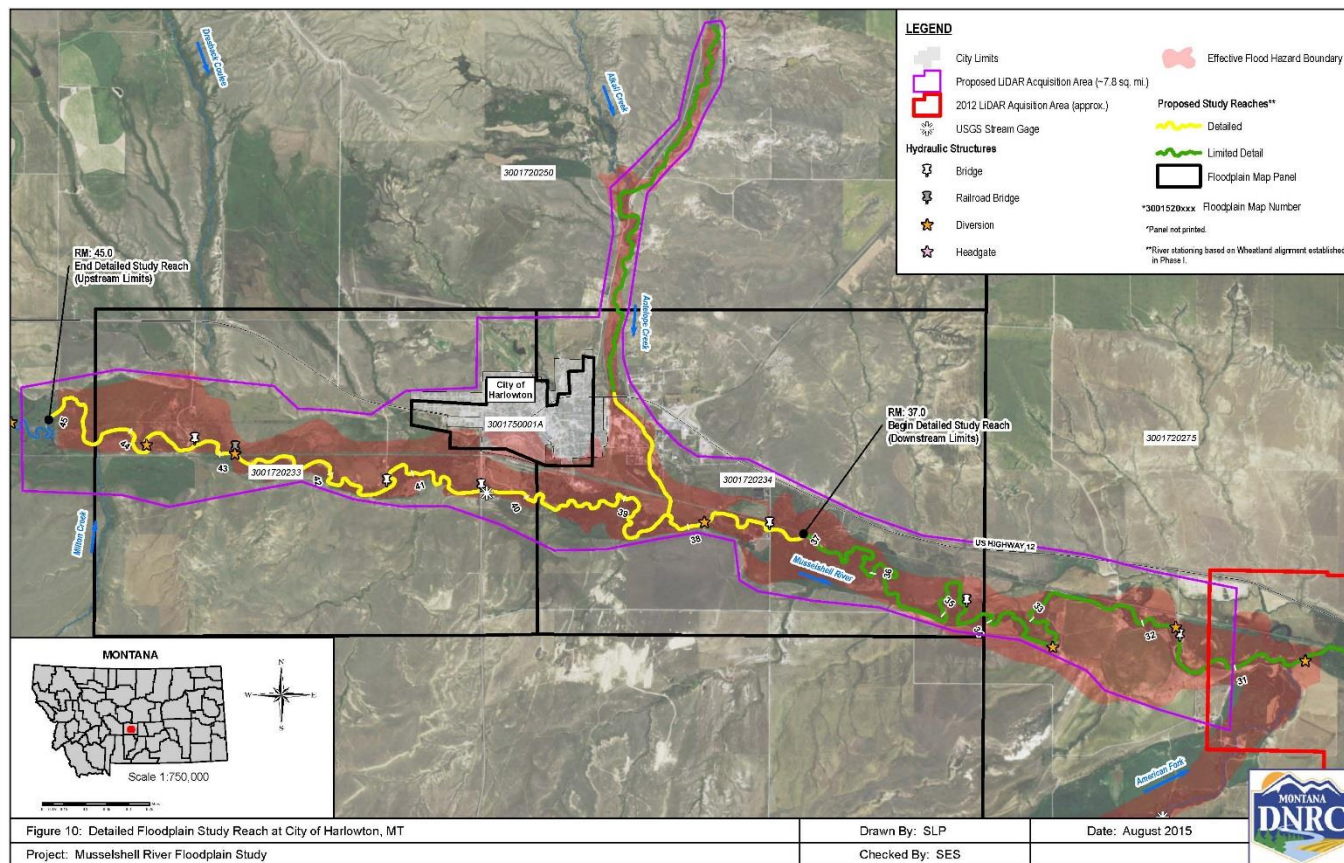
# Musselshell Watershed



# Wheatland County



# Wheatland County Harlowton



# Project Tasks

- Data Collection
  - Bathymetric Survey
  - Additional LiDAR
    - Town of Harlowton
- Basemap
  - Michael Baker International

# Project Tasks

- Hydrology
  - Musselshell Hydrology – Phase I Activity
  - Antelope Creek (Harlowton) - DNRC
- Hydraulic Modelling
- Mapping

# Data Collection

- Bathymetric Survey
  - 6 reaches, 36 miles
  - Bathymetric cross sections – over 330 surveyed
  - Hydraulic structures
- Landowner Access / Coordination
  - DNRC
  - Musselshell Watershed Coalition



## Thin Ice Surveying



# Data Collection

- LiDAR
  - Contractor: Quantum Spatial
  - Over 15 miles of Musselshell River
  - Over 4 miles of Antelope Creek
  - 9.3 square miles
  - November 14, 2015

# Data Collection

- LiDAR - Deliverables
  - 1.0 meter bare earth model
  - Raw point data
  - 0.5 meter contours





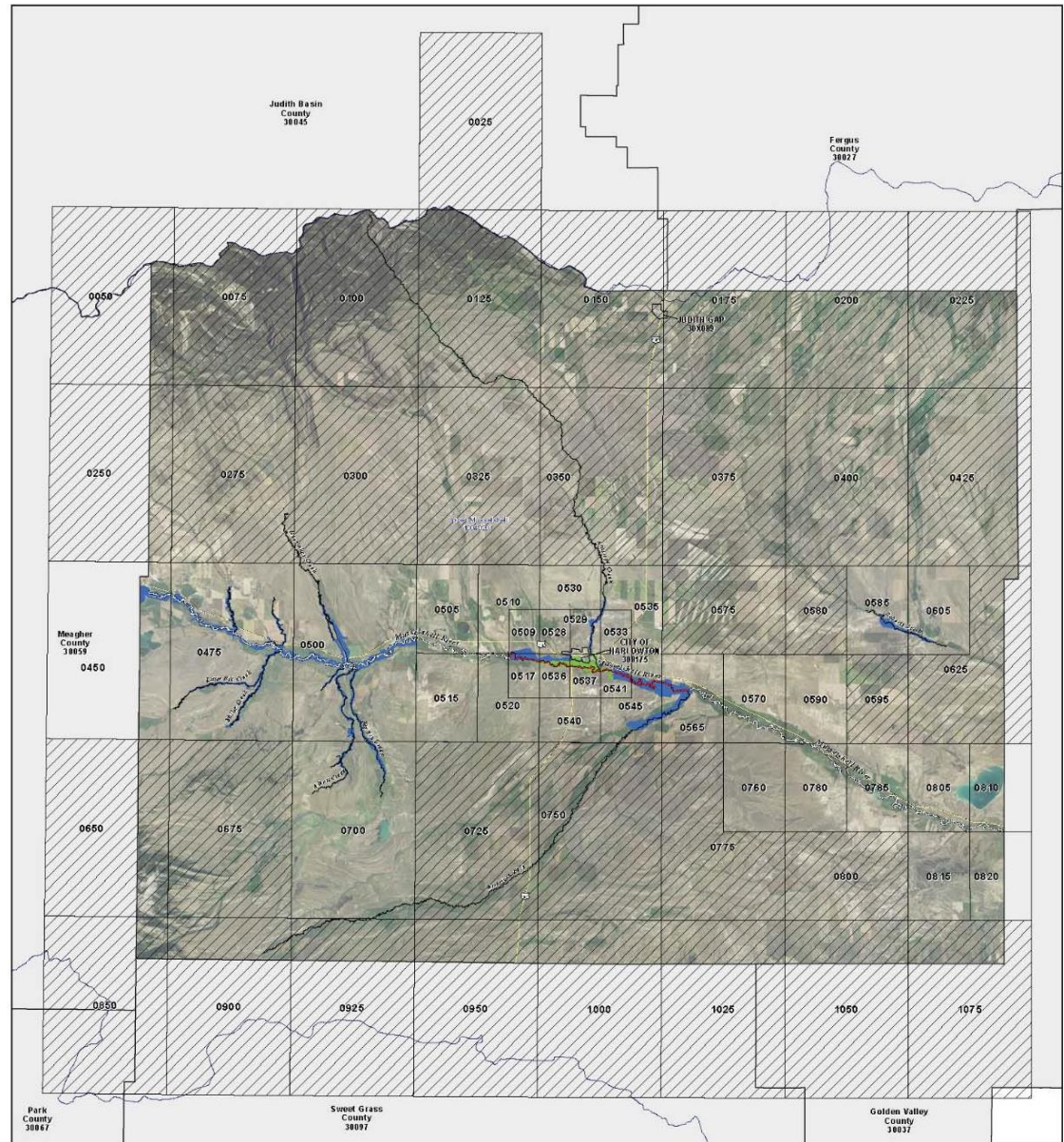
A view of downtown Harlowton, created from the gridded highest hit model colored by elevation (Quantum Spatial, 2016).

# Tasks

- Basemap
  - Contractor: Michael Baker, International
  - Basemap completed for Golden Valley, Musselshell, Petroleum, Rosebud, and Wheatland Counties
  - Based on a Countywide DFIRM format
  - 127 Panels across the five counties

# Scoping Map: Wheatland County

(Michael Baker  
International, 2015)



# Hydraulic Analysis

- Modelling and Model Setup
  - Review and analyze profile baseline
    - Aerial photography
  - Integrate cross sections with LiDAR surfaces
    - Cross section location and orientation
    - Merge bathymetric data (Detailed)
    - Integrate approximate channel dimensions (Limited Detailed)

# Profile Baseline Adjustment



# Hydraulic Analysis

- Modelling and Model Setup
  - US Army Corps of Engineers HEC-RAS v4.1.0
    - 1-Dimensional, steady flow
    - GeoHECRAS platform
  - Model reaches by county
  - Cross section input by analysis method
    - Detailed Study Methods
    - Limited Detailed Study Methods

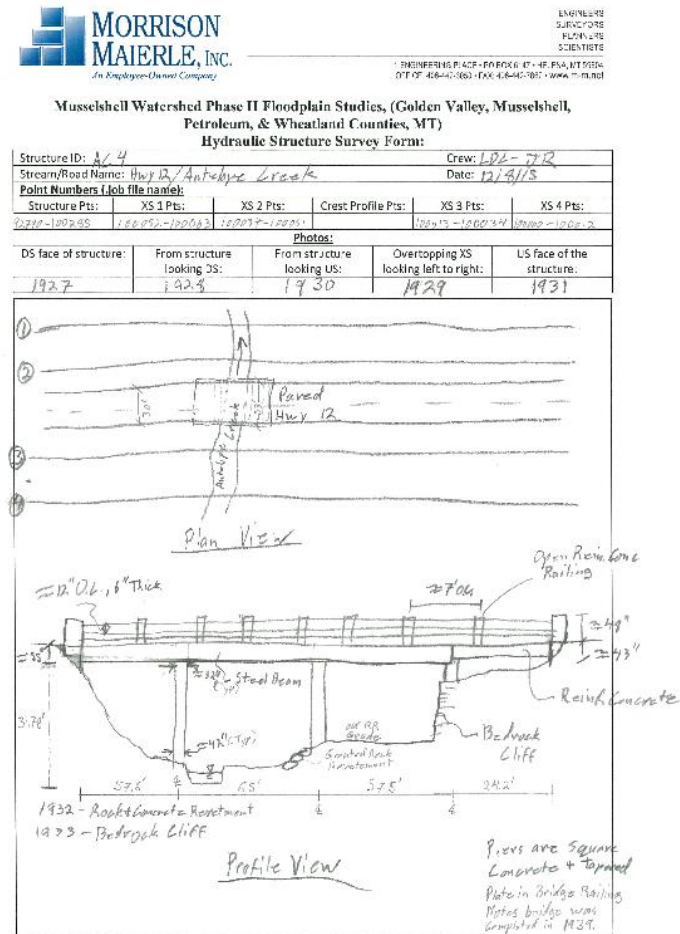
# Hydraulic Analysis

- Hydraulic Structures
  - Bridges
  - Culverts
  - Diversions



# Hydraulic Analysis

- Hydraulic Structures
  - Bridges
  - Culverts
  - Diversions



# Hydraulic Analysis

- Modelling and Model Setup
  - Mannings roughness assigned via land classifications from Department of Revenue
  - Flow change locations
    - 42 flow changes from Harlowton to end of project area
    - 18 flow changes across Musselshell County alone

# Hydraulic Analysis



# Hydraulic Analysis

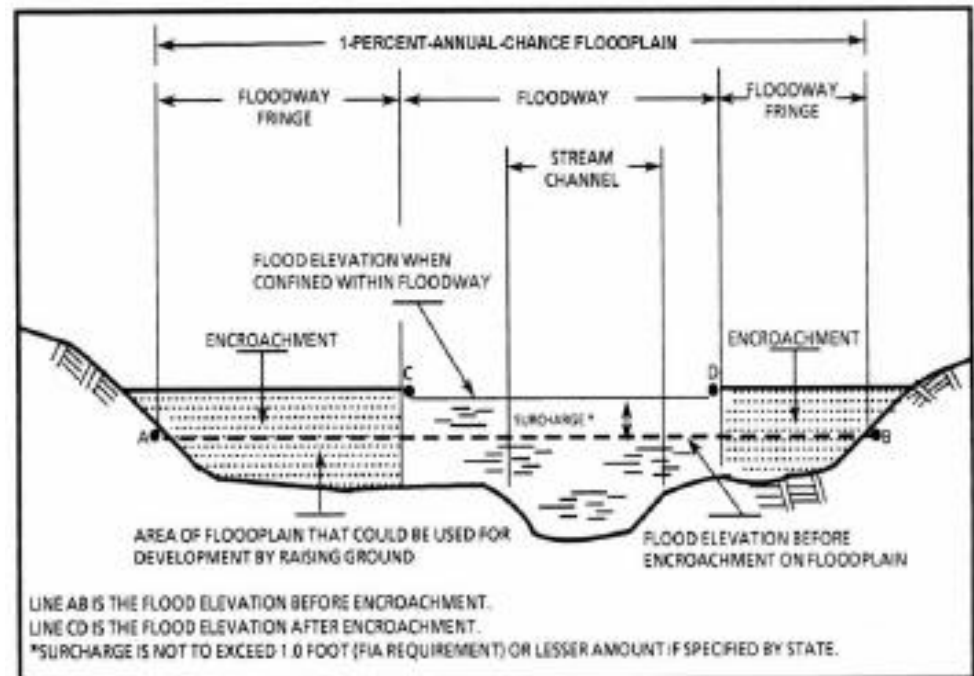
- Calibration
  - Aerial photography (MDT, Kestral Aerial Services, NAIP)
    - Gaged discharge
  - Compare modeled water surface elevations to WSE's determined via photography and ground surface data
  - Musselshell County – 23 locations
  - Petroleum County – 24 locations



(Kestral Aerial Services, 2011)

# Hydraulic Analysis

- Encroachment Analyses
  - Performed for detailed study areas



# Hydraulic Analysis

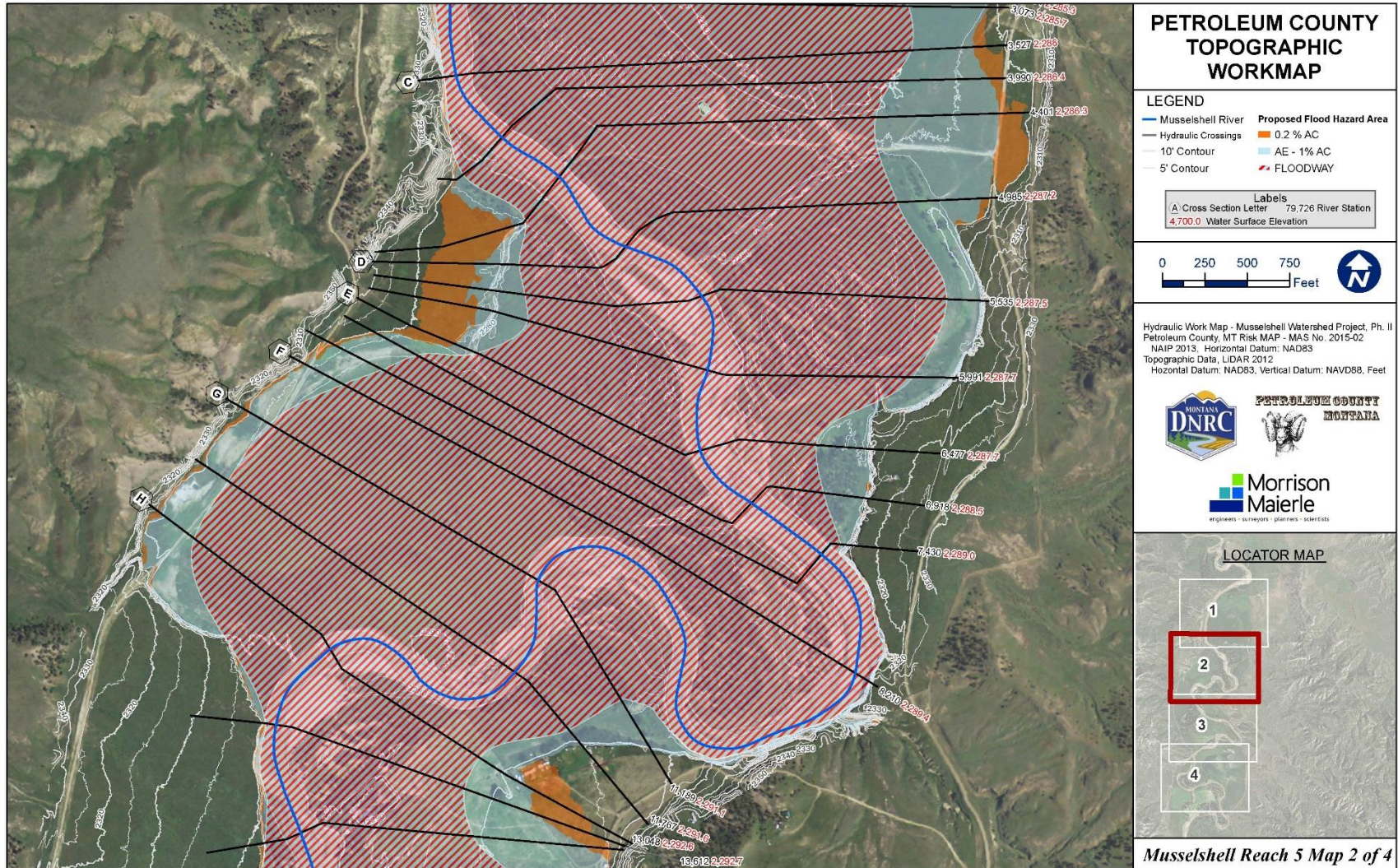
- QA/QC
  - cHECK-RAS results
  - Series of checklists and independent internal QA/QC
  - Verify widths, WSE, reach lengths, bridge flow conditions, mapping vs. model, profiles
  - DNRC pre-submittal review

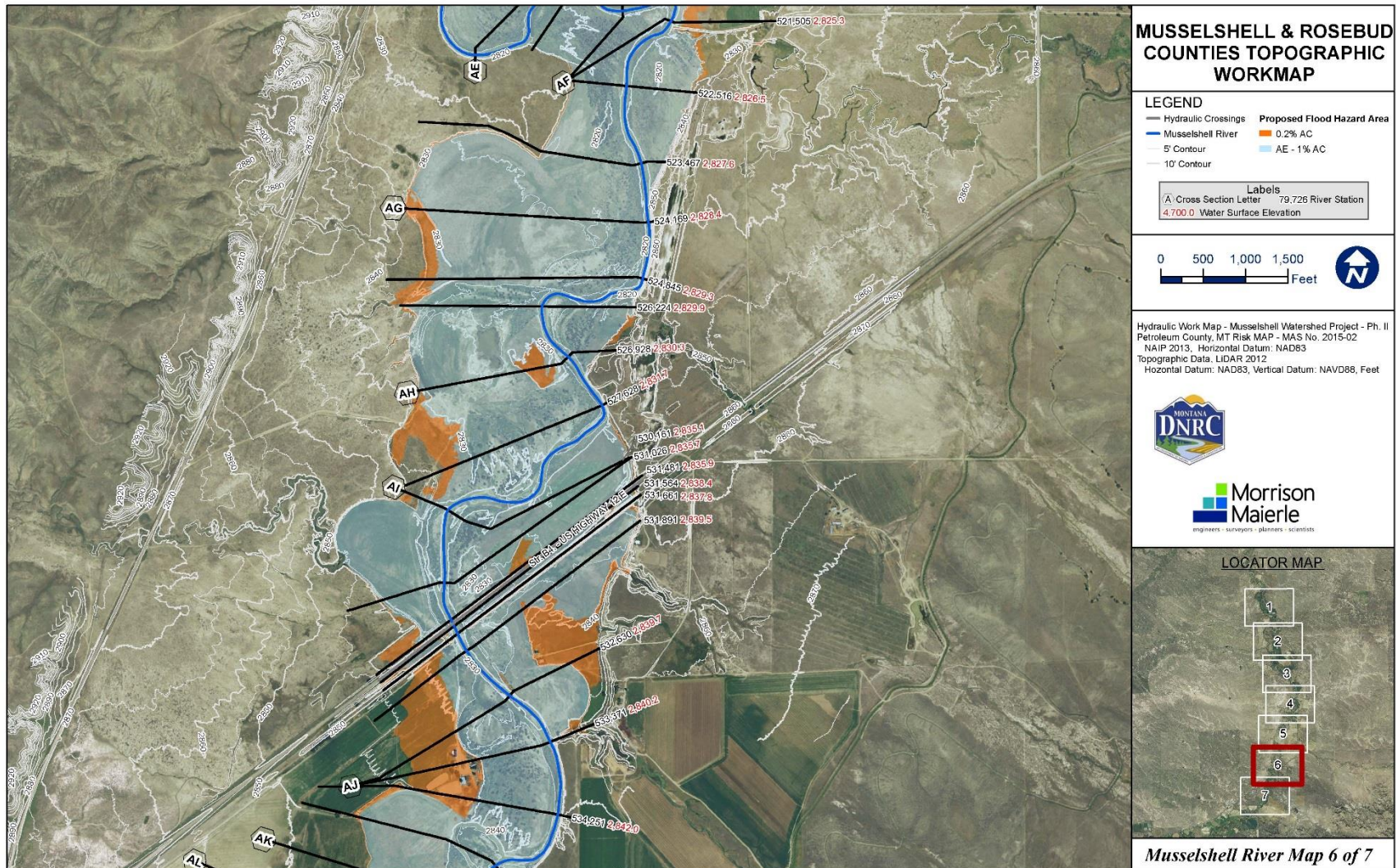
# Results

- Model Output
  - HEC-RAS output processed through GeoHECRAS
  - Shapefiles for 1% and 0.2% Annual Chance flood boundaries and floodway boundary

# Results

- Work Products
  - Detailed Hydraulic and Mapping Report
  - Workmaps
  - Profiles
  - Floodway data tables
  - Other deliverables specific to FEMA requirements (shapefiles, depth grids, CSLF)





# Schedule

- Phased Submittals
  - April 15, 2016
    - Reach 1 (106 miles Limited Detailed)
  - April 22, 2016
    - Reaches 5 and 6 (~14 miles Detailed)
  - May 27, 2016
    - Reaches 2 (44 miles Limited), 7 and 8 (8 miles Detailed)
  - June 3, 2016
    - Reaches 3 and 4 (40 miles Limited) and 9 and 10 (~13 miles Detailed)

# Summary

- New and Updated Flood Studies in Musselshell River Watershed
- Detailed and Limited Detailed Study Methods
- Draft Hydraulic and Workmap products in review over spring/summer 2016

# Thank You



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